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1. Title of the Research Proposal:

Green Synthesis and Characterization of Nanoparticles: Exploring Biological and Catalytic Activities

2. Choice of topic with reasoning:

The new era of chemistry is shifting towards the path of innovative techniques which mainly concentrate on environmental aspects. Nanoparticles have gained significant attention in various fields, including pharmaceutical and biological sciences, due to their unique properties and potential applications. The synthesis of nanoparticles allows for precise control over their size, shape, and surface properties, leading to enhanced drug delivery systems, diagnostic tools, and therapeutic interventions. Several methods are use for preparation of nanoparticles, but in some methods involved hazardous chemicals, costly chemicals, more energy consumption, not easily handled etc. [1]

hence, we will be used greenery method to the preparation of nanoparticles due to they are easily available, safe, and nontoxic. They have a broad type of metabolites that can aid in the reduction of metal ions. The use of plant extracts for nanoparticles synthesis is more advantageous than the other biological process as there is no troublesome of preserving and maintaining the cell culture and is a simple, one-step synthesis process with no chances of mutation as in microorganisms. The low cost of cultivation, short production time, safety and the capacity to up production volumes make plants an attractive platform for nanoparticle synthesis. The plants mediated synthesis of nanoparticles is free from harmful chemicals as well as providing natural capping agents for the stabilization of metal nanoparticles. [2-4]

The various metallic nanoparticles like gold, silver, platinum, zinc, copper, titanium dioxide, magnetic iron-ore, nickel etc. were synthesized from natural resources and are studied exclusively. The different parts of a plant such as a stem, root, fruit, seed, callus, peel, leaves and flower are used to syntheses of metallic nanoparticles in various shapes and sizes by biological approaches. Biosynthesis reaction may be altered by a wide range of metal concentration and quantity of plant extract in the reaction medium, it may transform the shapes and size of the nanoparticles. Biomolecules like proteins, amino acids, enzymes, polysaccharides, alkaloids, tannins, phenolic, saponins, terpenoids and vitamins that are

already established in the plant extracts having medicinal values and are environmentally benign, yet chemically complex structures. [5-7]

This proposed Ph.D. research aims to investigate the synthesis of nanoparticles and explore their biological and catalytic activities for the development of innovative therapeutic approaches. Nano catalyst is recently growing field applicable to almost all type of catalytic organic transformations.[8] These versatile semi heterogeneous nanocatalysts with high surface area are the best alternatives to conventional catalysts, the highest catalytic activity, selectivity and stability can be achieved by their shape, size, composition and nature of nanocatalyst. [9] Thus nanocatalyst is a substance that speed up or slow down chemical reaction without being consumed by them. Several forms of nanocatalyst such as magnetic nanocatalyst, nano mixed metal oxide, core shell nanocatalyst and nano supported catalysts have been employed in catalytic application. Metal nanocatalysts are promising material for the heterogeneous catalyst. In this context, the preparation of new highly active, sustainable and more selective nanocatalyst is of prime importance, especially in the field of organic synthesis.

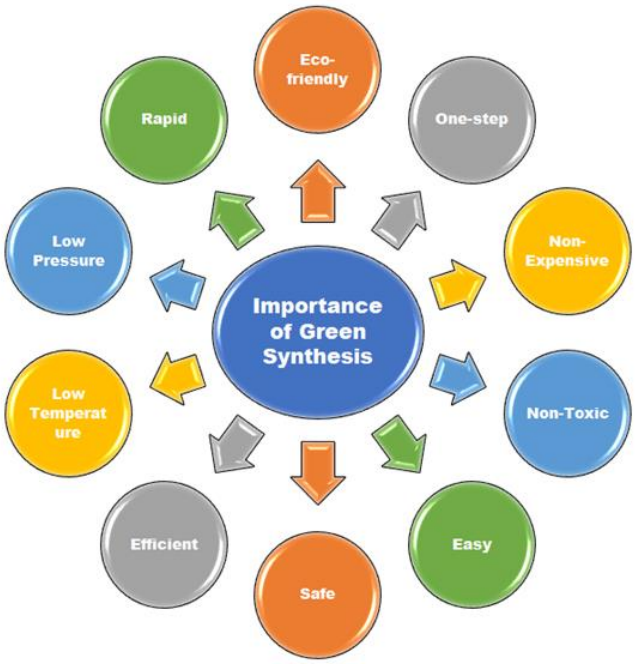


Fig 1. Various properties of Menal/Metal oxide NPs.

3. Significance of research work:

Reduction of particle size to nanometer scale provides unique properties which can be used in practice for development of novel materials. Nanocatalyst is an essential tool of green chemistry as it enables the development of less polluting chemical process and opens up synthetic path way to desired products using sustainable resources.[10] The isolation and recovery of nanocatalyst become difficult so it is important to use appropriate support to design selective reusable and sustainable nanocatalyst.[11] Metal nano particles deposited on the surface of various supporting materials to form supported metal catalyst have been widely studied in academic and industrial field. [12] Magnetic nanocatlyst have been extensively studied as the catalyst support essentially facilitating magnetic separation and recyclability. [13]

4. Statement of proposed problem:

Green synthesis, Characterization and Bi- evaluation of Metal/metal Oxide nanoparticles.
Proposed of the study: Being the relatively newer method than conventional methods of nanoparticle synthesis, the proposed problem leads to ecofriendly, non-hazardous and following the green chemistry principles for synthesis of novel nanoparticles.

5. Objectives of the study:

- To synthesize nanoparticles using various green methods and materials.
- To characterize the physicochemical properties of the synthesized nanoparticles by using several analytical techniques like XRD, UV, FT-IR, SEM-EDAX, HRTEM etc.
- To evaluate the biological and therapeutic applications of synthesized nanoparticles.
- To transformation of organic reactions using synthesized nanoparticles.
- To characterize the prepared organic compounds through spectroscopic techniques (FTIR, 1H NMR, etc.)

6. Hypothesis of the study:

Preparation of metal nanoparticles using chemical method leads to hazardous reaction condition, expensive technique, required longer time, difficult to separation of nanoparticles, required high energy and pressure but in green synthesis of nanoparticles leads to non-hazardous reaction condition, ecofriendly, single steps reaction, no longer time required, no side product formed, green solvent is used like water. The advantages of green synthesis of nanoparticle using plants are that the plants are easily available and safe to handle and possess a large variety of active agents that can promote the reduction of metal ions. The proposed problem will lead to novel NP's synthesis, its characterization and Bio evaluation of plants parts. The applications for nanoparticles are growing rapidly and including in electronic as sensor, drug delivery, catalyst, domestic waste water treatment.

Also, the use of nanocatalysts for organic synthesis is most significance because it includes some important advantages such as short reaction time, high yield, simple methodology, easy workup procedure and green reaction conditions. It is believed that these well-constructed nanocatalyst with various energy sources such as microwave technology, ball milling, ultra sonication will help the accomplishment of being and sustainable chemical processes. The aim of present research is to synthesize various nanocatalysts by using greenery methods/techniques and its biological evaluation as well as transformation of various organic synthesis. [14, 15]

Therefore, the research efforts have been directed towards synthesis of nanocatalyst and its role in biological activities and organic synthesis, which will satisfy many criteria of green chemistry of organic compound.

7. Research methodology and outline of research work:

NPs can be synthesized by physical and chemical methods including mechanical milling process commonly used in the metalworking industry. Basically, there two types of methods to synthesis of nanoparticles.

A) **Top-down approach:**

- **Mechanochemical method**: It is a cost-effective pathway to make nano-powders using ball-shaped mills in low-temperature chemical reactors where the grinding balls increase the kinetic reaction of the reactant powders and provide the required temperature for the reactions by their movements. [16]
- **Sputtering**: The sputtering, technique of thin film deposition, is suitable for high melting point materials.
- **Etching**: is one of the common techniques for removing and transferring materials in the generation of NMs and NPs and can be performed by electric or chemical arc discharge methods. [17]

B) **Bottom Approach**:

- **Greener synthesis of MNPs/MONPs**: Due to industrialization problems related to the physical processes and the use of toxic and expensive chemicals in the synthesis of nanoparticles, alternative greener syntheses methods have garnered major attention In these greener options, living organisms such as plants, bacteria, fungi, algae and lichens, or constituents from these organisms, are used to synthesize nanoparticles from the metal ions among these, plants are preferred over physical and chemical methods due to their availability, low cost, and eco-friendly nature. Interestingly, these nanoparticles can be sustainably synthesized by using industrial wastes and agricultural residues and often they have better biological and catalytic activity than nanoparticles synthesized by conventional methods using harsh chemicals. [18-21]
- **Chemical reduction methods**: Reduction of metal salts is the most common strategy to synthesize MNPs/MONPs, which can also be mass-produced at room temperature in one-pot reaction conditions. [22]

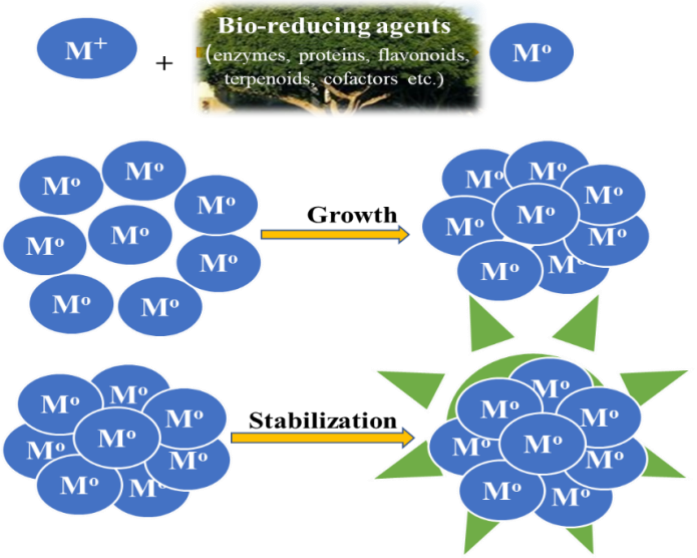


Fig. 2. Reduction process on metal ions

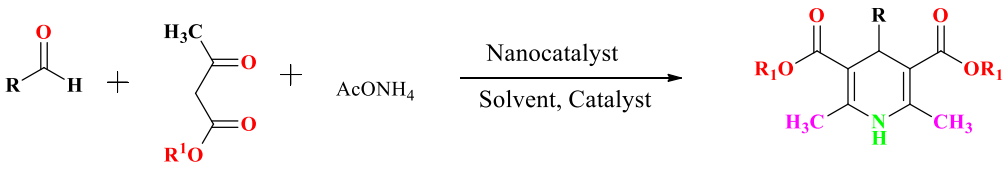
- **Wet chemistry**: Wet chemistry methods are the most common bottom-up protocols deployed for synthesizing a wide range of nanomaterials. [23]

Biological Evaluations: The synthesized nanoparticles will be assessed for their biological evaluations as well as catalytic performance in transformation of organic reactions.

Some examples of organic reactions transformation by Nano catalyst.

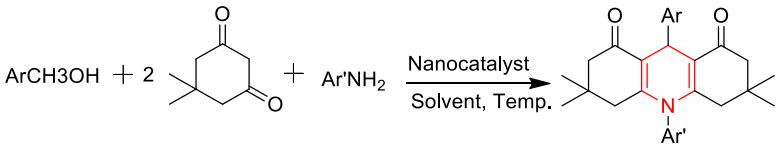
Reaction of o-phenylenediamines and ketone in aqueous medium by efficient recyclable heterogeneous nanocatalyst.

Nano catalyst used to the synthesis of 1,4-DHPs with heigh yield.



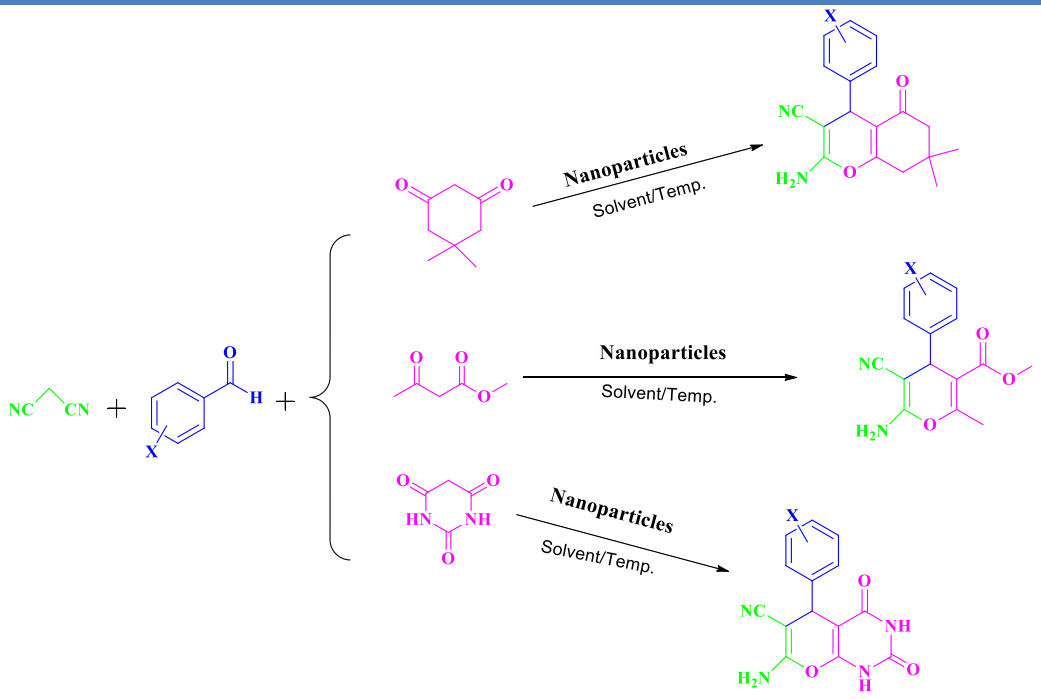
Scheme 1

Nano catalyst to synthesize 1,8-dioxo-decahydroacridine derivatives in a solvent-free condition.



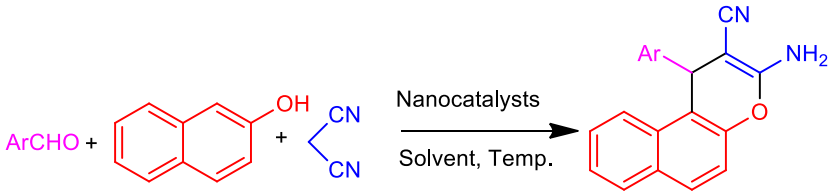
Scheme 2

Nanocatalyzed synthesis of pyran derivatives.



Scheme 3

Synthesized nanoparticle thin films that catalyzed the synthesis of 3-amino-1aryl-1H-benzo.



Scheme 4

8. Characterization:

Comprehensive characterization techniques, such as X-ray diffraction (XRD), EDS, transmission electron microscopy (TEM), FESEM, FTIR, UV-Visible study and surface area analysis, will be utilized to evaluate the physicochemical properties of the synthesized nanoparticles.

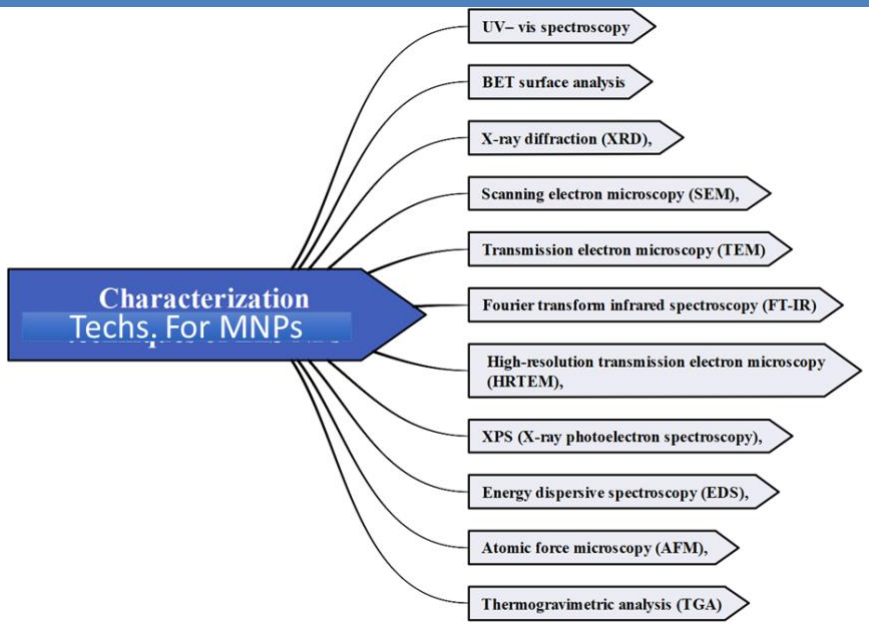


Fig.3. Characterization techs. For Metal/Metal oxide nanoparticles

synthesized organic compounds will be confirmed by spectroscopic analysis like FIIR, 1HNMR etc.

9. Chapter scheme:

- Introduction from literature survey.
- Collection, Identification, and authentication of plant for Synthesis, characterization, of novel nanoparticles by using various materials like plant extract/microorganisms/wastes/naturally available materials etc. (2 to 3 or 4 chapters)
- Biological evaluation of synthesized nanoparticles and its catalytic activities.
- Future scope.

10. Expected outcomes:

- The successful completion work will result in development of newer greener synthetic route/methodology of metal/metal oxide nanoparticles to overcome the synthetic difficulties.
- The resultant cost-efficient high yield nanoparticles will possess enhanced biological and therapeutic properties.
- Synthesized NPs may have catalytic applications in organic synthesis.

- On the basis of the experimental work, several research papers with scientific value and dissemination to chemistry and material science conference/publications are planned.

11. Plan of work semester wise:

The proposed work on phytochemical study of plants mainly focused on green synthesis of metal/metal oxide nanoparticles, characterizations and testing of biological study as well as catalytic applications. In order to achieve the respective objectives following activities are planned.

Semester First -

- To carry out extensive Literature survey.
- Review paper writing.
- Field survey to select/collection of materials (plants/other materials etc) for phytochemical study
- To complete first six-month progress report

Semester second-

- Identification and authentication of plants.
- To purchase required chemicals and instrument.
- Preparation metal/metal oxide nanoparticles.

- To complete second six-month progress report.

Semester Third-

- Characterization of metal/metal oxide nanoparticles.
- Biological evaluations.
- Catalytic activity and its confirmation.
- Paper writing and communication

Semester Fourth-

- Preparation of other metal/metal oxide nanoparticles.
- Characterization and biological study of other metal/metal oxide nanoparticles.
- Biological evaluations.
- Catalytic activity and its confirmation.
- Papers writing and communication

Semester Fifth-

- Papers publication process
- Thesis writing

Semester Sixth

- Thesis writing
- submission

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